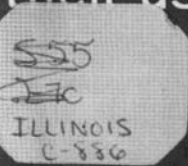


PLANT REGULATOR
their use as a hobby



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PLANT REGULATORS: their use as a hobby

SYNTHETIC plant-growth regulators are relatively new products. But natural plant regulators are as old as plant life itself. They are organic substances which are produced within the plant and which control specific processes. Actually they may be considered plant hormones, comparable with the hormones, such as insulin, that are produced in animals.

A balance of hormones accounts for the fact that roots grow down and shoots grow up. Hormones explain the responses of plants to light. Dwarfism and many other plant phenomena are also explained by the absence or presence of certain regulatory agents.

An animal may have insulin or some other hormone supplied artificially and go on living a normal life. Similarly, a synthetic regulator can be applied to plants, altering their growth without destroying or injuring them.

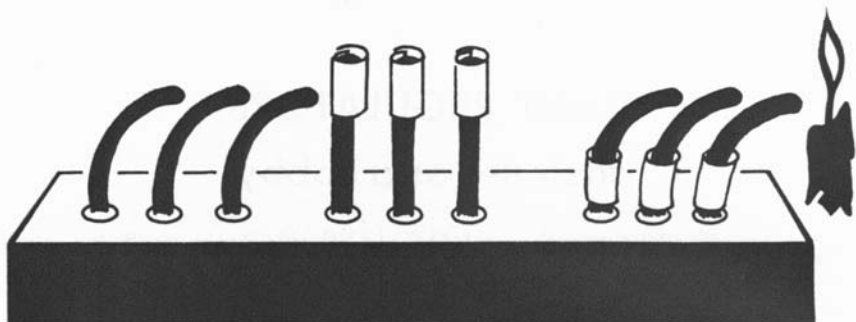
Many practical uses have been found for the synthetic plant regulators. This circular describes the use of regulators to (1) encourage the rooting of cuttings; (2) increase plant, flower, and fruit size; (3) get better fruit set and produce seedless fruit; (4) control weeds; and (5) retard growth.

Regulators can also be used to prevent pre-harvest fruit drop, thin fruit, prevent sprouting, aid sprouting, bring about earlier flowering, and hasten germination.

Discovery of plant regulators

In the mid-nineteenth century, Charles Darwin conducted some experiments that may be considered the first studies of plant hormones. These experiments concerned the effect of artificial light on grass seedlings in a darkened room. When he left a candle in the room for a time, the plants bent toward the light. This continued to happen after he had covered the lower parts of the plants with metallic foil. Covering the tops of the plants, however, kept them from bending. Darwin concluded that the bending was due to something produced by the stem tip and conducted to the lower part of the plant.

In other experiments Darwin put plants in a horizontal position and noted that the shoots soon began to bend upward. This indicated

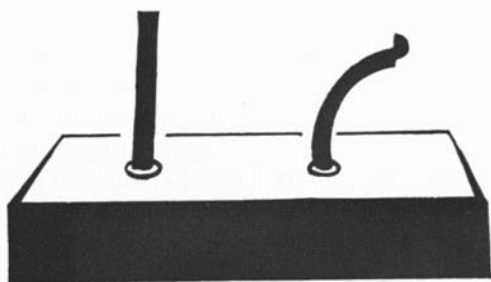


Darwin observed that, in a darkened room, plants bent toward artificial light. They continued to do this when the lower parts were covered with foil, but not when the upper parts were covered. Presumably the bending was caused by something produced in the stem tip.

Other experiments by Darwin concerned geotropic responses in plants. After placing a plant in a horizontal position, he noticed that the plant soon began to bend upward. Evidently something in the plant was causing a negative gravitational attraction.



A. Paal determined that curvature in plants is due to an unequal distribution of a growth-regulating substance. This he learned by cutting the tip from an oat coleoptile and replacing the tip to one side of the stump. The side of the stump under the tip grew more than the other side, causing a pronounced curve in the plant.



that something in the plants caused the shoots to overcome the pull of gravity.

For some years after Darwin, little was learned about the substances causing different growth responses in plants. Since the early years of this century, however, a number of experimenters have accumulated information about plant hormones. One of these was A. Paal, whose experiment on curvature in oat plants is illustrated on page 4.

Isolation and analysis of regulators

After scientists were relatively certain that plant-regulating materials did exist, the next step was to obtain enough for chemical analyses. The first regulator to be isolated was one called auxin. This work was done by F. Kögl and A. H. Haagen-Smith. With H. Erxleben, they later identified 3-indoleacetic acid, calling it heteroauxin.

The discovery of gibberellic acid stemmed from the work in Japan on "foolish seedling disease" of rice. In 1926 E. Kurosawa found that the disease was caused by chemicals from a fungus which grew on rice plants. He also found that filtrates from the fungus caused the seedling to elongate abnormally. In 1938 T. Yabuta and Y. Sumiki isolated the substance causing this elongation and called it gibberellin.

Once a material was isolated and characterized, it could then be synthesized chemically. By now many different regulators have been synthesized and are commercially available. In this circular we will be concerned with specific chemicals for obtaining a desired result, rather than with all those which might be used.

Methods of applying regulators

Aerosol applicators serve well for treating small numbers of plants. The aerosol bomb contains the material in a solution. A valve on top of the can releases the solution as a mist which may be directed where desired. The nozzle of the applicator should be held about a foot from the plant so that the escaping material will not freeze or otherwise injure the plants.

Some growth regulators are available as concentrated liquids or as powders or other dry forms. The chief use of the dry forms is in rooting compounds. Regulators may be applied to plants in water spray, lanolin paste, vapor, and concentrated solutions. Lanolin paste is often used in experiments for close control. Vapor may be used in enclosed areas such as a greenhouse or specially built chambers.

ROOTING COMPOUNDS

Shortly after indoleacetic acid was synthesized, it was welcomed by horticulturists as an aid in rooting cuttings. Since then, many other synthetic chemicals that encourage rooting have been developed.

Rooting aids will in no way replace certain environmental conditions necessary for cuttings to root. These conditions include adequate light, water, and humidity, and proper temperature. Age of the plant and the part of the plant from which the cutting is taken affect rooting. There are also differences between species and between varieties of the same species. Some plants do not root any better with rooting compounds than without them.



As shown at right, cuttings vary widely in their response to rooting compounds.

Species to use

Following are a few types of cuttings that usually root better after treatment. They are grouped according to relative ease of rooting.

Easy to root. Camellia, carnation, chrysanthemum, coleus, English ivy, euonymus, forsythia, impatiens, philodendron, poinsettia, rose, willow.

Intermediate. Azalea, barberry, currant, dogwood, holly, honeysuckle, hydrangea, juniper, magnolia, privet, quince, yew.

Hard to root. Apple, fir, maple.

Taking and preparing cuttings

Usually the youngest parts of the plant root the best. The effect of greater age can be somewhat overcome, however, by using rooting compounds.

Hardwood (mature) cuttings of conifers and broadleaf evergreens should be taken from October through December. Similar cuttings of deciduous trees and shrubs are usually taken during late fall or winter. The cuttings should be cut down to 6 or 8 inches and stored in a cool place until ready to root. Hardwood cuttings usually root well in the spring.

Softwood or herbaceous cuttings may be taken at any time. If necessary, they may be enclosed in a plastic bag and stored at near-freezing temperatures for a few weeks before being set out.

Treating cuttings

Rooting compounds may be obtained through most garden and nursery catalogs, as well as at local garden stores. Use these compounds strictly according to directions on the package. Proper concentrations are of critical importance.

The following methods of treatment will usually prove satisfactory. However, the manufacturer may give different directions for specific materials. If so, follow the directions on the container.

Rooting powder. Cut off the base of the stem to just below a bud or node. Strip the leaves from the basal 1 to 1½ inches of the stem. (Be sure to remember which is the basal end. If cuttings are put into the propagator upside down they won't root.)

Dip the basal ½ to 1 inch in water and shake to remove excess water. Stick the moistened end into the powder. Get rid of excess powder by tapping gently or by blowing.

Now stick the base of the cutting 1 to 1½ inches below the surface of the rooting medium in the plant propagator.

Quick dip method. Cut off the base of the stem and strip the leaves from the basal end as described under "rooting powder."

Immerse the bottom inch of the cutting in a concentrate solution for a few seconds. Remove the cutting and shake off the excess solution. Place the base of the cutting in the rooting medium.

Basal soak method. This is like the quick dip method, except the cuttings are left in a dilute solution for a rather long period, usually 24 hours.

Propagators

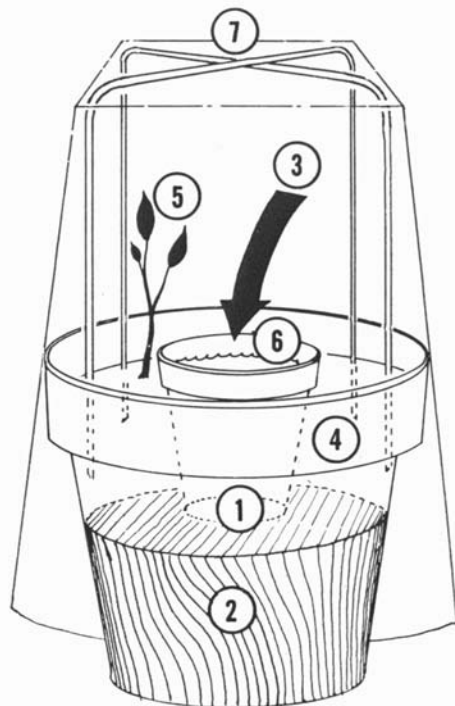
A plant propagator will usually be needed to root the cuttings, although some cuttings may be stuck directly into the soil and will still root successfully.

The simplest propagators consist of boxes filled with sand, vermiculite, or sphagnum moss. The propagators need constant care, however, to keep the rooting medium moist. Simple self-watering propagators can be bought, or can be built as shown on page 8.

Care for cuttings in propagator

It is imperative that cuttings never be allowed to wilt. The rooting medium must be watered well while the cuttings are rooting, but it should not be waterlogged.

The time needed to root the cuttings will vary. Softwood and herbaceous cuttings usually root in a short time but hardwood cuttings



A simple and serviceable plant propagator can be constructed with these materials:

- A 7" or 8" unglazed clay pot
- A 3½" or 4" unglazed clay pot
- Cork stopper
- Vermiculite
- Heavy wire
- A clear plastic bag

To build the propagator, follow these steps:

1. Place the cork stopper in the drain hole in the bottom of the smaller pot.
2. Fill the larger pot half way with vermiculite.
3. Set the small pot in center of large pot. Fill large pot with vermiculite to about ½ inch from top of small one.
4. Bend heavy wires to form a canopy over the large pot, and stick these wires into the vermiculite.
5. Stick cuttings in vermiculite.
6. Thoroughly saturate the vermiculite and fill the inner pot with water to the top.
7. Cover frame with clear plastic bag.

take longer. Wait at least a week before you check the softwoods for rooting, and 4 to 5 weeks before you check the hardwoods.

Plants can be removed from the propagator and transplanted any time after they have rooted. Good results are often achieved if the plants don't have too many roots longer than ½ inch.

Use of control plants

It is a good idea to put a few untreated cuttings in the propagator along with the treated cuttings, to see just how much better the treated ones do. You may find that a root stimulant makes little difference and that you won't want to use it again for a particular species.

Other uses for rooting hormones

Root, mallet, and leaf-bud cuttings, as well as stem cuttings, will often root better with rooting aids. Various methods of vegetative propagation, such as mound layering, air layering, and tip layering, may be greatly accelerated with the use of rooting hormones. (See also *Home Propagation of Ornamental Trees and Shrubs*, U. S. Department of Agriculture Home and Garden Bulletin 80.)

PLANT STIMULANTS

Some plant regulators can increase the size of plants, flowers, and fruits. One such regulator, which has received much attention recently and which offers possibilities to the person who wants to do a little experimenting at home, is gibberellic acid. It is relatively easy to use and the results are usually quite apparent.

Applying gibberellic acid

Gibberellic acid is available from the larger garden supply houses and may sometimes be obtained from local sources. It usually comes in an aerosol can, which is the form that will be considered here. For large-scale operations and experimental work, a lanolin paste or a water solution may be used.

Applications are usually made after the 5-leaf stage. A seed treatment might benefit some plants.

Amount to apply depends on the plant and its size. Spraying with an aerosol bomb for 2 or 3 seconds will be enough for most plants, while 5 seconds may be needed for the largest plants. If a plant is a fast grower, one application may give the desired results. Several weekly or biweekly applications may be needed for a plant that grows slowly.

Suggested experiments

Treat geranium blossoms before they open and when the color is just beginning to show. Observe differences in size and color between treated and untreated plants.

Treat tomato plants at weekly intervals from the 5-leaf stage until they bloom. Notice the differences between treated and untreated plants.

Other experiments may be worked out to fit specific situations. The following modifications have been observed in plants treated with gibberellic acid: Dwarfism has been overcome. Long-day annuals and biennials have flowered earlier. Growth, flowering, and fruiting have been more uniform. Light requirements for growth and development have been altered. Effects of temperatures that are not optimum for plant development have also been modified. And potatoes have sprouted faster and more uniformly.

Certain undesirable effects have also been attributed to gibberellic acid: no heads on lettuce, chlorosis (yellowing) in plants, legginess or excessive growth, and abnormal leaf shape and size. Results also vary according to season of the year, age of the plant, and species.

FRUIT-SETTING COMPOUNDS

Several compounds will aid in the setting of fruit and hence the production of seedless fruit. All of them contain auxins. These substances, which are produced naturally in the plant at the time of fertilization, cause cells to enlarge and fruit to grow. When auxin is supplied artificially to plants, the fruit develops, but, as would be expected, seed is not produced unless natural fertilization has occurred.

Uses of the compounds

Fruit-setting compounds are frequently used on tomatoes in the greenhouse, where there are no insects to aid natural fertilization. These compounds may also be applied in the field to obtain early fruit set, especially if damp, cool weather delays natural pollination.

Another use of the compounds is to obtain fruit set upon self-sterile plants (those that will not fertilize themselves because of some genetic barrier). The compounds may also be used on species that bear the female flowers and male flowers on separate plants. Such a species is the American holly. Two plants of different sexes must be grown close together for fertilization to take place and for berries to form on the female plant. With the use of fruit-setting compounds, berries can be formed without natural fertilization.

Availability of the compounds

Fruit-setting compounds may be obtained at local stores and through most garden catalogs. They are commonly available in aerosol cans, which are convenient for small applications. Water-soluble forms, available only in rather large quantities, are used to treat large commercial areas. Other forms would be used in closely controlled work and in overcoming certain adverse weather conditions.

Application

Some of the earliest known materials caused serious damage when applied to the entire plant. This is not true of more recently developed materials. Even so, it is more economical to treat only the blossoms. Direct the spray material into the flower, and spray for a second or two. If an aerosol bomb is used, hold the nozzle a foot from the blossom so as not to freeze it.

Application time may be critical in getting maximum fruit size and producing seedless fruit. If the flower is treated just after it opens and shows color, the fruit will probably be seedless but otherwise normal. If the flower is well along before treatment, then the fruit will



Hold aerosol can about a foot from the plant and direct the spray directly into the blossom.



Fruit-setting compounds are especially effective on tomatoes.

develop normally and probably have seeds. A couple of applications, one just before the flowers open and one afterwards, may increase both number and size of fruits.

Suggested experiments

Tomatoes respond well to treatment with fruit-setting compounds. You will have an excellent opportunity to experiment if you grow tomatoes indoors or if you make a few especially early indoor plantings for later transplanting. Leaving a few plants untreated will enable you to evaluate the effectiveness of treatment.

Emasculation of the flower may be useful in determining whether fruit set was due to natural pollination or to the fruit-setting compound (see *Plant Breeding as a Hobby*, Illinois Circular 817).

The blossoms of blackberries, strawberries, squash, and other plants can be treated and the fruit checked for earliness of development, size, and presence of seeds.

WEED CONTROL WITH 2,4-D

Many good herbicides are available. The most important, however, is 2,4-D (2,4-dichlorophenoxyacetic acid). It kills a large number of weeds, is relatively inexpensive, and is widely available.

Effect on plants

The effect of 2,4-D on plants is not completely understood. It is active in much lower concentrations than indoleacetic acid (IAA).

2,4-D is chiefly a broadleaf weed killer. Grasses are generally resistant but a few, such as bentgrass, are susceptible. And any grass may be injured or killed if it is in the early stage of growth or if the rate of application is very high.

When 2,4-D is applied at levels too low to kill a plant, it causes several structural changes: The tip of the stem grows rapidly and this excess growth causes the tip to bend downward. The stem enlarges greatly just above the soil. Roots grow less than the rest of the plant.

Very low concentrations of 2,4-D will promote growth. It has been used to root cuttings, get better fruit set, delay blossoming, and reduce preharvest fruit drop. Other chemicals, however, work just as well or better for these purposes.

Precautions should be observed.

Many crop and ornamental plants are highly susceptible to 2,4-D. Among the common susceptible plants are tomatoes, grapes, and red-bud trees. Spray drift has been known to damage plants as far as a half mile from the sprayed area. In some sections, 2,4-D has caused so much trouble that its use is forbidden by law.

If you use 2,4-D near susceptible plants, choose a method of application that will cause little drift or volatility of material. Under any circumstance, use extreme caution when applying 2,4-D.

The drift hazard, while always a problem, varies with a number of factors:

Wind. It is not wise to spray on a windy day.

Volatility. The ester form is quite volatile and must be used with special caution.

Fineness of the spray. This depends on nozzle size and pressure. The finer the material, the more the drift.

Other factors, such as sprayer height, will also affect drift.

It is wise to keep a sprayer for 2,4-D only. If the same sprayer has to be used for 2,4-D and for insecticides, it should be well washed



Plant at far left received no 2,4-D. Plant at near left received 2,4-D in amounts that were too small to kill the plant, but were great enough to cause rapid growth of the stem tip. This caused downward bending of the plant.

with household ammonia, sal soda, or trisodium phosphate after it has contained 2,4-D. Otherwise the residue may be a problem.

Forms of 2,4-D

2,4-D may be bought at garden stores, nurseries, or oil companies. The ester and amine forms are most common. Sodium and ammonium salts are not as readily available, but may be obtained in granular form.

The ester form is more toxic than the amine. About half as much actual material is needed when the ester is used as when the amine is used. Since the ester is highly volatile, it should be used only where it will not damage susceptible plants. The amine form is relatively non-volatile. Since it is readily soluble in water, it may be easier to use in certain spray equipment.

Application methods

Spraying is the most common method of applying 2,4-D. A small hand sprayer that covers a few square inches at a time may be used, or a large mechanical sprayer that covers several square yards.

Other methods of application include spreading granules with a lawn seeder or fertilizer applicator. A wax bar impregnated with 2,4-D may be pulled over an area. Some of the wax containing the 2,4-D will come off on the weeds. Another device has a plunger by which a measured amount of 2,4-D can be applied to a plant.

Time to apply

Both crops and weeds are more resistant to 2,4-D at some times than at others. As a rule, mature plants are less affected than young ones.

Many weeds are easily controlled with small amounts of 2,4-D in a pre-emergence application — that is, an application made before the weeds come up. However, the crop plants themselves are more easily killed at this time and the stand may be materially reduced unless the treatment is made with great care. 2,4-D is therefore commonly used as a post-emergence spray. The treatment is made directly on the weeds.

Amount to apply

The amount of 2,4-D to use depends on the crop to be treated, the weeds to be killed, and the environmental conditions. Amounts to use on different crops are given on the container. These recommendations should be closely followed.

If you have any questions that are not answered on the container, seek help from your county Extension adviser, one of the publications listed on page 16, or the person who sells the material. You may also write to the Department of Horticulture, University of Illinois.

Suggested experiments

Apply 2,4-D as recommended to a lawn infested with broadleaf weeds such as dandelions and plantains. You may leave a control plot or adjoining lawn area untreated to observe the differences between treated and untreated areas.

Other experiments may be conducted to note changes in structure or growth caused by 2,4-D. A few seedling tomatoes may be treated with different amounts of 2,4-D and growth modifications noted. Very low concentrations of 2,4-D might be tried on bean plants to see if plant size is increased.

GROWTH RETARDANTS

The first successful dwarfing of plants with chemicals was done by scientists of the Agricultural Research Service in 1948. Since that time many different materials have been tested, and a few have shown promise for wide-scale use. So far retardants have been chiefly used in the florist industry.

Three of the commonest materials at present are CCC (Cycocel), B-9, and phosphon. CCC and B-9 have been used successfully on poinsettias; and phosphon and B-9 on Easter lilies, chrysanthemums, and certain garden annuals such as petunias.

Effects and value of retardants

Reduced plant height (shorter internodes) is the chief effect of these chemicals. They also cause some slowdown in growth, which is reflected in a longer plant life. In general, retardants improve the appearance of ornamentals by making them more compact, with darker green leaves. CCC and B-9 have recently been found to induce flowering of azaleas and rhododendrons at any time of year.

Retardants do not reduce dry weight. Nor do they change the environmental requirements of a plant. None of the retardants tried to date has affected all species.

These materials are so new that it is difficult to gauge their ultimate value. It appears, however, that they will be valuable for use with many ornamentals. Tall lilies and chrysanthemums, for example, have been shortened into satisfactory pot plants. There is also a potential use of retardants to reduce the size of trees and shrubs where they are grown in confined space.

Methods and amounts

Growth retardants can be obtained from garden and florist supply houses in a wide range of package sizes. Usually the smallest package should serve for experimental purposes.

CCC and phosphon generally give good results when used as soil drenches. They are less effective when applied as sprays and may even cause injury. B-9, however, is used as a spray.

For certain plants, the required amounts of a specific retardant have been worked out experimentally and are given on the container. For other plants, you will have to do your own experimenting to determine optimum amounts.

Suggested experiments

Retardants are rather easy to work with. Many experiments are possible, working with different plants, application rates, and chemicals.

Pots of tall varieties of petunias or zinnias could be drenched or sprayed with different amounts of a retardant. Generally it is best to add the chemical after a plant is well established, rather than at the time of seeding or at the seedling stage.

(See back cover for other references on plant growth regulators.)

REFERENCES

This circular is a brief treatment of a complex science. For further information on plant growth regulators, the following books will prove helpful:

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